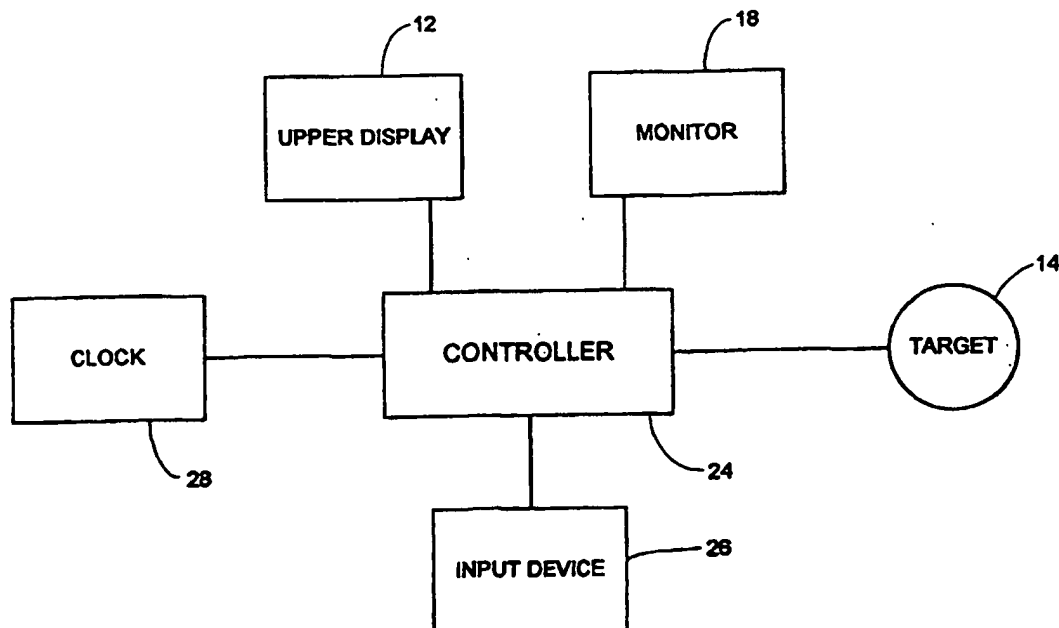


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(54) Title: METHOD AND APPARATUS FOR PLAYING A TIME-LIMITED DART GAME



## (57) Abstract

A dart game method and apparatus utilize an electronic dart machine (10) having an electronically scored target (14) and an electronic controller that, in addition to performing automatic scoring and game sequencing, is also used to provide time handicapping of individual players.

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METHOD AND APPARATUS FOR  
PLAYING A TIME-LIMITED DART GAME

5

TECHNICAL FIELD

This invention relates to electronic dart machines.

10

BACKGROUND OF THE INVENTION

Electronic dart machines have become a popular way for dart enthusiasts and neophytes alike to enjoy the game of darts. By automatically tallying scores and performing the basic game sequencing, these machines allow players to focus their attention on the more enjoyable aspects of the game. These machines employ an electronically scored dartboard, or target, to detect and register the impact of a dart. European Patent No. EP 0 495 539 B1 provides an example of such an electronically scored target. The target disclosed in this patent includes movable segments that have integral pins located on their rear side adjacent a printed circuit board. The segments are biased away from the printed circuit board. This bias is overcome by impact of a dart on the segment, forcing the pins into contact with the printed circuit board, thereby closing a switch. The switch closure is detected by a suitable control circuit and used to generate and display a player score.

Today, these machines are mostly microprocessor-based and include game programming that enables the user to select any of a number of different, known dart games. High-Score, Shanghai, 310, 501, 701,

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Cricket, and Elimination are a few examples of popular games that have been implemented in the game programming of commercially available dart machines.

5               Software control of scoring and game sequencing has also been used to provide new dart games that are, in essence, variations of known games. For example, U.S. Patent No. 5,401,033 discloses an  
10       electronic dart game that provides a variation of cricket. In this game, instead of using the standard six target sectors 15 through 20, the sectors are randomly selected by the dart machine prior to the first round. If a selected sector is hit, that sector is  
15       maintained as one of the six selected cricket sectors for the remainder of the game. After the first round, any unhit selected sectors are replaced for the next round by a new, randomly selected sector. As long as a selected sector remains unhit, this process repeats each round until six selected sectors have been locked-in.  
20       Thereafter, play continues as in normal cricket using the locked-in sectors. As with other variations of conventional dart games, this cricket game differs from traditional cricket primarily in terms of what sectors are to be targeted by the players and how those sectors  
25       are selected. Other aspects of the game remain the same.

              In circumstances where handicapping of one or more players is desired, dart games typically use one of  
30       two techniques for implementing the player handicaps; namely, adjusting the initial score or allocating one or more spot darts. These handicaps can be implemented in electronic dart machines prior to the start of game play. See, for example, U.S. Patent No. 5,593,349 and  
35       International Application No. WO 94/09337.

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SUMMARY OF THE INVENTION

5       The present invention provides a dart machine  
for playing a game of darts that is organized into a  
number of rounds with one or more players taking a turn  
throwing darts in succession during each round. The  
dart machine is of the type that includes an  
electronically scored target and an electronic  
10       controller coupled to the target. The dart machine is  
characterized in that the controller is operable during  
a player's turn to initiate a selected time interval and  
to electronically score only those darts that hit the  
target prior to expiration of the time interval.

15       The time interval can be a fixed preset  
interval, or, preferably, can be selected by the player  
within certain constraints. For games involving two or  
more players, each of the players can select their own  
20       time interval. Advantageously, this "time handicapping"  
of players provides an alternative to conventional dart  
handicapping techniques that involve points or spot  
darts.

25       In accordance with another feature of the  
invention, the controller is operable to electronically  
score only those darts that hit one or more designated  
sectors of the target prior to expiration of a time  
interval. This provides a dual challenge to the player;  
30       namely, hitting a designated sector in a limited amount  
of time.

35       In accordance with yet another aspect of the  
invention, there is provided a method of operating a  
dart machine having an electronically scored target,

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wherein the method includes the steps of throwing a number of darts in succession at the target, electronically detecting impacts of the darts on the target, and generating a player score. The method is  
5 characterized by the steps of starting a timer, scoring each dart that impacts the target while said timer is running, and excluding from the player score any dart that impacts the target after the timer has expired.

10 The use of time constraints on game play provides a duality of advantages. Not only does it provide exciting game play that can benefit from strategizing by the players, but it also shortens the total game time, thereby increasing coin box receipts  
15 and, ultimately, the profits of the owner or lessee.

#### BRIEF DESCRIPTION OF THE DRAWINGS

20 A preferred exemplary embodiment of the present invention will hereinafter be described in conjunction with the appended drawings, wherein like designations denote like elements, and:

25 Figure 1 is a front view of a preferred embodiment of an electronic dart machine of the invention;

30 Figure 2 is a block diagram of the electrical system of the dart machine of Fig. 1;

Figure 3 is a front view of the upper display of the dart machine of Fig. 1;

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Figure 4 is a flow chart depicting a portion of program code used to permit players to individually select the time intervals used for game play;

5           Figure 5 is a flow chart depicting a portion of program code used to control scoring and the initiation and monitoring of the selected time interval; and

10           Figure 6 is a flow chart depicting a portion of program code used to provide a new time-limited dart game.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15           Referring to Fig. 1, there is shown an electronic dart machine of the present invention, designated generally as 10, that includes an upper display 12, a target 14, a card reader 16, a monitor 18, and a conventional coin and bill acceptor 20. Target 14 can be a conventional, electronically scored target having target segments that provide a signal whenever the segment is struck by a dart. See, for example, U.S. Patent Nos. 4,586,716, issued May 6, 1986 to R.J. Brejcha et al., and 4,836,557, issued June 6, 1989 to D.P. DeVale et al. The disclosures of these patents are hereby incorporated by reference. As will be appreciated from the discussion below, both displays (upper display 12 and monitor 18) are not required.

30           With reference to Fig. 2, the electrical system of dart machine 10 will now be described. At the heart of the system is a microprocessor-based controller 24 that has outputs connected to upper display 12 and monitor 18 and inputs connected to target 14, an input

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device 26, and a clock 28. A more detailed block diagram of a suitable controller is disclosed in U.S. Patent No. 5,593,349, issued January 14, 1997 to E.K. Miguel et al., and the complete disclosure of that  
5 patent is hereby incorporated by reference. Input device 26 is an optional data entry device, such as a keyboard, a touch-sensitive surface on monitor 18, or a group of switches that can be used in lieu of or in addition to target 14 as a means of entering information  
10 into dart machine 10. Clock 28 can be a crystal oscillator used to provide a clock input to the microprocessor of controller 24.

Controller 24 includes a game program that  
15 controls setup, play, and scoring of various dart games. As will now be described, one or more of these games can utilize time handicapping either as an option or as an inherent feature of the game. Time handicapping involves limiting the amount of time that a player has  
20 to throw his or her darts during a round. In dart machine 10, time handicapping is implemented by allowing each player to select a time interval prior to start of game play. Then, these intervals are stored by dart machine 10 and used during each round when the players  
25 take their turn.

In its broader aspects, time handicapping can be implemented by setting the time interval equal to a predetermined length of time that is the same for all  
30 players. However, the ability to specify different time intervals for each player advantageously permits players to be handicapped according to their ability, thus leveling the playing field and making the contest more challenging.

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The time interval is measured using a timer, which can implemented in any of a number of ways, including in software or by a simple logic circuit or even by use of a counter or other discrete logic device.

5 With software, the timer can be implemented by incrementing or decrementing a variable or by monitoring a system clock to determine when a selected period of time has elapsed. Preferably, for each player in each round, the timer is initiated in response to dart

10 machine 10 detecting the first dart thrown by that player. However, the time interval could also be initiated automatically at the beginning of the player's turn and could be accompanied by a visual or audible signal indicating commencement of the time interval.

15 Once the time interval is initiated, the player must complete the throwing of his or her darts (usually three darts total per round) prior to expiration of the timer and any darts that hit the target after the time interval has ended will not be scored. If desired,

20 separate time intervals could be used for each of a player's later throws (e.g., the second and third throws), with the impact of each throw on the target beginning the timer for the next throw.

25 When used as a part of a league or tournament system, such as is disclosed in the above-noted and incorporated U.S. Patent No. 5,593,349, time handicaps can be calculated by the central league computer, transmitted to the dart machine, and then applied

30 automatically. Alternatively, the league computer can provide the dart machine with conventional handicap information for a player, which can then be converted by the dart machine into a time handicap.

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Once the time interval has been initiated (whether by throwing the first dart or otherwise), dart machine 10 provides a visual display of the time remaining in the interval. This can be accomplished using monitor 18 to display a graphical image of, for example, a bar graph or an analog or digital stopwatch counting down to zero. Preferably, however, this visual display is accomplished using upper display 12. Turning now to Fig. 3, upper display 12 includes a centrally located cricket scoring matrix 30 of LEDs 32 or other light sources. Upper display 12 also includes four, seven-segment LED displays 34 for displaying player scores. Matrix 30 is separated into seven columns of twelve LEDs 32 that are arranged into four horizontal rows of three LEDs each. Each of these columns corresponds to one of the seven sectors of target 14 utilized in the play of cricket. As shown in Fig. 3, this arrangement results in four rows of twenty-one LEDs, with each row being assigned to one of the four potential players of cricket.

When not being used for the game of cricket, matrix 30 can be used to provide a bar graph for each player that shows how much time they have remaining in their time interval. In particular, the twenty-one LEDs in each row correspond to a total time interval that is preselected and stored in the dart machine. Thus, each LED corresponds to a shorter time interval; namely,  $1/21$  of the total time interval. Prior to start of the game, the players each select their time interval by specifying the desired number of LEDs. For example, if the total time interval is seven seconds, each LED corresponds to a shorter time interval of one-third of a second. Thus, if Player 1 specifies eighteen LEDs, then that player will have a selected time interval of

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six seconds. Similarly, if Player 2 specifies fourteen LEDs, then that player will have a selected time interval of four and two-thirds seconds.

5           Once a player has selected his or her time interval, the corresponding number of LEDs will be illuminated in that player's row of matrix 30. This is shown in Fig. 3 for the Player 1 and Player 2 time intervals given above. Then, when a player's turn  
10 begins and the timer is started, the LEDs in that player's row extinguish one at a time, from right to left, over the course of the interval. In this way, LEDs 32 provide a bar graph that indicates the time remaining in the selected time interval. The  
15 implementation of this bar graph can be viewed more generally as comprising a row having a predetermined number  $m$  of light sources wherein the dart machine includes an input device for receiving an input number  $n$  entered by the player, where  $0 < n \leq m$ , and wherein  
20 the controller 24 is operable to set the selected time interval equal to  $(n/m)T$ , where  $T$  is a preselected total time interval, and wherein the controller is further operable to cause the display to illuminate  $n$  of the light sources in the row at the start of the player's  
25 turn.

To avoid confusion while a player is taking his turn, the bar graphs for the other players can be temporarily extinguished. Alternatively, all four rows  
30 can be temporarily used to simultaneously display the current player's bar graph. Other such variations will become apparent to those skilled in the art.

Entry by a player of the selected number of  
35 LEDs can be accomplished using target 14, with each of

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the numbered sectors 1-20 being used to specify a corresponding number of LEDs and the bullseye being used to specify all twenty-one LEDs. Alternatively, the game program can initially illuminate all twenty-one lights and a momentary button or switch on the dart machine can then be used to decrement the number of LEDs one at a time. In this alternative embodiment, the dart machine would preferably have three momentary switches, one to decrement the count of LEDs, another to increment the count, and the third to enter the selected number of LEDs into the dart machine. During this initial setup, the LEDs would be extinguished or illuminated in succession, depending on whether the count was being incremented or decremented.

15

An audible signalling of the time remaining in the selected time interval can be provided in lieu of or in addition to the visual display. For example, an intermittent "beep" or "tick" can be provided as the timer is running and preferably each time an LED in the bar graph is extinguished. Also, the extinguishing of LEDs and/or the intermittent audible sound can be carried out at equal intervals over the selected time interval or could be determined in accordance with a more complex mathematical function so as to provide, for example, a countdown that accelerates as the interval nears its end.

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Dart machine 10 also enables the owner or lessee of the dart machine to exercise control over the range of time intervals available to players. In particular, the total time interval (e.g., all 21 LEDs) can be set at any of a number of values within a certain range. In the example given above, a total time interval of seven seconds was used. However, by placing

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the dart machine in a service mode, this total time interval can be increased or decreased within certain limits. Thus, for instance, if the total time interval is decreased to five seconds, then Player 2's fourteen  
5 LEDs would provide a selected time interval of three and one-third seconds.

As mentioned above, the time handicapping can be implemented as an option or inherent feature of many  
10 of the well-known dart games, such as 301, 501, or 701. Figs. 4 and 5 depict flow charts of program code that can be used to provide this time handicapping and it will be appreciated that this code would preferably be incorporated into a larger game program; for example, it  
15 might replace the handicapping setup routine disclosed in U.S. Patent No. 5,593,349. To enter into the routine of Fig. 4, the first player selects a player change button 38 (shown in Fig. 1) at the appropriate point in the game setup routine. This is indicated at block 40  
20 of Fig. 4. Then, at block 42, the player selects his or her time interval (either using target 14 or another input device), following which, the player change button is pressed again to enter or lock-in the selected time interval. This is indicated at block 44. Then, the  
25 process waits to see if the player change button is pressed again, as shown in block 46. If so, the process loops back to block 42 to allow the next player to select his or her time interval. This is indicated at block 48. If the player change button was not pressed  
30 at block 46, then the flow moves to block 50 where a check is made to see if the game start button has been pressed. If so, then the flow moves out of this routine to finish any other setup options and begin game play. This is shown at block 52. If the game start button has  
35 not been pressed, then flows moves to block 54 where a

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check is made to see how much time has passed since the player change button was last pressed. If a certain amount of time has passed, then it is assumed that the players are ready to start game play and the flow moves  
5 on to block 52. If the time period has not passed, then flow loops back to block 46 to again make checks for either a player change button press or a start game button press.

10 Fig. 5 discloses the process within a game program for initiating and monitoring the timer and scoring timely hits on the target. It begins at start block 56, following which program flow moves to block 58 where a check is made to see if a dart has been  
15 detected. If not, flow moves to block 60 where a check is made to see if the time has yet been started. In this embodiment, the timer is not begun until after the player's first dart is thrown. Prior to that first throw, the timer will be off and the process flow will  
20 loop back to block 58 where a check is again made to see if a dart has hit the target. If the timer has been started, flow moves to block 62 where the timer is checked to see whether time has elapsed. If not, flow loops back to block 58. If so, then the player's round  
25 is over and the program moves on to give the next player his or her turn.

If, at block 58, a dart was detected, then flow moves to block 66 where the dart hit is scored.  
30 Then, at block 68, a check is made to determine if that dart was the first one of the round for the current player. If so, flow moves to block 70 to start the timer, following which the flow returns to block 58 to check for the next dart. If, at block 68, it is  
35 determined that the current dart was not the first one

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of the round for that player, then a check is made to see if it is the last (e.g., 3rd) dart thrown by that player for the round. This is indicated at block 72. If not, flow returns to block 58 to check for another  
5 dart. If the current dart is the last dart for that player, then the flow moves to block 64 for the start of the next player's turn. The process of Fig. 5 will then be repeated each round for each player. Although only certain portions of a complete game program are shown,  
10 it will be appreciated that the remainder of the game programming is known to those skilled in the art and need not be elaborated upon here.

The ability to place time limitations on game  
15 play also creates the possibility of entirely new games. In accordance with one aspect of the invention, this is accomplished by combining time limited play with the ability to designate only one or more sectors which can be scored for any given throw or throws. In this game,  
20 players select their time handicaps as described above, preferably by using the cricket matrix 30 and target 14. Then, first round play proceeds with the first player being given a single designated sector to hit with the first throw, then a different, single designated sector  
25 to hit with the second throw, and then finally, a third different, single designated sector to hit with the third throw. If there are one or more other players, then they each take their turn throwing at the same three sectors (one shot per sector). As with the time  
30 handicapping discussed above, the timer preferably starts upon impact of each player's first throw, necessitating that they throw the remaining two darts within the selected time interval. If desired, separate time intervals could be provided for each of the second  
35 and third throws. When a player hits the designated

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sector, that player scores the point value (1-20 or bullseye) of that sector. There are seven rounds for a total of twenty-one darts and the program is configured to designate each and every sector only once per game.

5 Thus, each player gets a single chance to hit each sector and score that sector's points. The designated sectors for each round can be preprogrammed into the game or can be randomly selected by the game.

10 Referring now to Fig. 6, a portion of program code used for implementing the game will now be described. Once the players have entered their time handicaps, the game starts at block 74 with the first major step being to select the first segment of the  
15 first round. This is indicated at block 76. This sector is the designated for the player by a suitable display on upper display 12 or monitor 18, if present. Alternatively, the visual designation could be by, for example, illuminating the target sector itself. Once  
20 the sector has been selected and designated, the process flow moves to block 78 where a check is made to see if a dart has been detected. If not, flow moves to block 80 to see if the timer has been started. As in the time handicapping described above, the timer is preferably  
25 started immediately following impact of the first dart. If the timer has not yet started running, then the process loops back to block 78 to again check for a dart. If the timer has started, then the flow moves to block 82 to determine whether the timer has elapsed. If  
30 the timer has not expired, flow loops back to block 78. If it has expired, then the player's turn is over and the program moves on to the next player, whether it be for the next round or the same round. This is shown at block 84.

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If, back at block 78, a dart was detected, flow moves to block 86 where a check is made to see whether the dart hit the single, designated sector. If the dart did not hit the designated sector, then flow moves to block 88. If the sector was hit, then the process moves to block 90 before moving to block 88 so that the dart hit can be electronically scored. At block 88 a check is made to see if the thrown dart was the player's first dart of the round. If so, the timer is started and the flow returns to block 76 for selection and designation of a new sector. If the dart was not the player's first of the round, then the flow moves to block 94 to check to see if it was the player's third dart. If so, the round is over for that player and the flow moves to block 84. If it was the second dart, then the process returns to block 76 for selection and designation of the third sector of the round. This process repeats for each player and for each round of the game until each of the twenty-one sectors has been designated once. Thereafter, the game ends. For games involving two or more players, the player with the highest point score after all seven rounds is the winner.

To make the game more challenging, the first, second, and third designated sectors for each round can be selected by the program from the following three groups of sectors, respectively: 1-7, 8-14, and 15-bullseye. Thus, the first designated sector for each round is always from the group 1-7. This means that the first dart of each round, which is not being thrown under any time pressure, is only being thrown at a low-scoring sector. On the other hand, the last throw of each round, which is being thrown at a high-scoring sector, must be thrown under the greatest time pressure,

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since it is nearest the end of the selected time interval. This allows for strategizing as, for example, where a player will desire to throw the second dart quickly so as to maximize the amount of time available to properly and precisely aim and throw that player's last dart of the round.

As will be readily apparent to those skilled in the art, other variations can be made that include the combination of a time constraint along with targeting of specific sectors, without departing from the invention. For example, rather than a single sector being designated, a number of sectors could be designated at the same time, with a bonus being given for hitting more than one sector in a round or hitting the sectors in numeric order. Also, the players can be given different sets of sectors to throw at during a single round. Furthermore, a bonus can be awarded in the event of hitting multiple designated sectors in a single round. The bonus could be in the form of points, a point multiplier, or even a time credit that is added onto the player's selected time interval during one or more subsequent rounds.

The use of time-constraints permits other time-related features to be incorporated into dart games. For example, each time a player finishes a round prior to expiration of the timer (i.e., prior to expiration of the selected time interval), the remaining time left in the interval can be accumulated for that player. Then, in the event a game ends in a tie, the accumulated totals for each player can be compared and the player with the greatest remaining time can be declared the winner. As another example, these accumulated totals could be converted into points at the

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end of a game and added to each player's score, so that players get credited for quicker play.

5       The selected time intervals can also be automatically adjusted by the dart machine as the game proceeds. Thus, for example, the selected time intervals could be shortened as the game proceeds to increase the difficulty in the later rounds.

10       It will thus be apparent that there has been provided in accordance with the present invention a method and apparatus for playing a time-limited dart game which achieves the aims and advantages specified herein. It will of course be understood that the  
15       foregoing description is of preferred exemplary embodiments of the invention and that the invention is not limited to the specific embodiments shown. Various changes and modifications will become apparent to those skilled in the art and all such variations and  
20       modifications are intended to come within the scope of the appended claims.

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CLAIMS

We claim:

5           1.    In a dart machine for playing a game of  
              darts that is organized into a number of rounds with one  
              or more players taking a turn throwing darts in  
              succession during each round, the dart machine having an  
10           electronically scored target and an electronic  
              controller coupled to said target,

              characterized in that:

              said controller is operable during a player's  
15           turn to initiate a selected time interval and to  
              electronically score only those darts that hit the  
              target prior to expiration of the time interval.

              2.   A dart machine as defined in claim 1,  
20           wherein said controller begins the time interval in  
              response to impact of a dart on said target.

              3.   A dart machine as defined in claim 1,  
              wherein said controller is operable prior to start of  
25           game play to store a time interval for each of a number  
              of players, whereby each player may have a different  
              period of time in which to throw the darts.

              4.   A dart machine as defined in claim 1,  
30           wherein the time interval comprises a number of shorter  
              time intervals and wherein the dart machine includes an  
              output device coupled to said controller, said output  
              device being responsive to a signal from said controller  
              to provide a perceptible indication of the expiration of  
35           each of the shorter time intervals.

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5. A dart machine as defined in claim 4, wherein said output device comprises an audio device that produces an audible sound after the expiration of each of the shorter time intervals.

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6. A dart machine as defined in claim 4, wherein said output device comprises a display.

7. A dart machine as defined in claim 6, wherein said display includes a set of light sources with said controller being operable to illuminate a number of said light sources prior to the start of the time interval and to then successively extinguish said light sources over the course of the time interval.

15

8. A dart machine as defined in claim 7, wherein said display includes a cricket display having a matrix of light sources, wherein said set of light sources comprises a row of said matrix.

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9. A dart machine as defined in claim 8, wherein said row has a predetermined number  $m$  of light sources and wherein the dart machine includes an input device coupled to said controller for receiving an input number  $n$  entered by the player, where  $0 < n \leq m$ , and wherein said controller is operable to set the time interval equal to  $(n/m)T$ , where  $T$  is a preselected total time interval, and wherein said controller is further operable to cause the display to illuminate  $n$  of the light sources in said row at the start of the player's turn.

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10. A dart machine as defined in claim 9, wherein said controller is operable to successively extinguish said  $n$  light sources over the course of the

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time interval, whereby said illuminated light sources operate as a bar graph that depicts the time remaining in the time interval.

5           11. A dart machine as defined in claim 9, wherein said input device comprises said target.

10           12. A dart machine as defined in claim 6, wherein said display is a screen comprising an array of pixels, wherein said controller uses said screen to display the amount of time remaining in the time interval.

15           13. A dart machine as defined in claim 12, wherein said controller is operable to display on said screen a timer that decrements whenever one of the shorter time intervals expires.

20           14. A dart machine as defined in claim 6, wherein said display is a numeric scoring display used to display player scores.

25           15. A dart machine as defined in claim 4, wherein the length of each of said shorter time intervals is determined in accordance with a mathematical function.

30           16. A dart machine as defined in claim 1, wherein said target has a plurality of target sectors that includes a bullseye and a group of numbered sectors and wherein said controller is operable to designate a subset of said target sectors and to electronically score only those darts that hit the designated sectors prior to expiration of the time interval.

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17. A dart machine as defined in claim 1,  
wherein said target has a plurality of target sectors  
that includes a bullseye and a group of numbered sectors  
and wherein said controller is operable to designate  
5 certain ones of said target sectors one at a time and to  
electronically score only those darts that hit a  
currently designated sector prior to expiration of the  
time interval.

10 18. A dart machine as defined in claim 17,  
wherein said controller is operable to designate each of  
said target sectors one at a time during game play.

15 19. A dart machine as defined in claim 1,  
wherein said target has a plurality of target sectors  
that includes a bullseye and a group of numbered sectors  
and wherein said controller is operable to randomly  
select one or more of said target sectors prior to at  
least one of the rounds.

20 20. A method of operating a dart machine  
having an electronically scored target, wherein the  
method includes the steps of throwing a number of darts  
in succession at the target, electronically detecting  
25 impacts of the darts on the target, and generating a  
player score,

wherein the method is characterized by the  
steps of:

30 starting a timer;

scoring each dart that impacts the target  
while said timer is running; and

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excluding from the player score any dart that impacts the target after the timer has expired.

21. The method of claim 20, wherein the  
5 method is characterized by the step of beginning the timer in response to a first one of the darts impacting the target.

22. The method of claim 20, wherein the  
10 method is characterized by the step of beginning the timer prior to throwing of any of the darts.



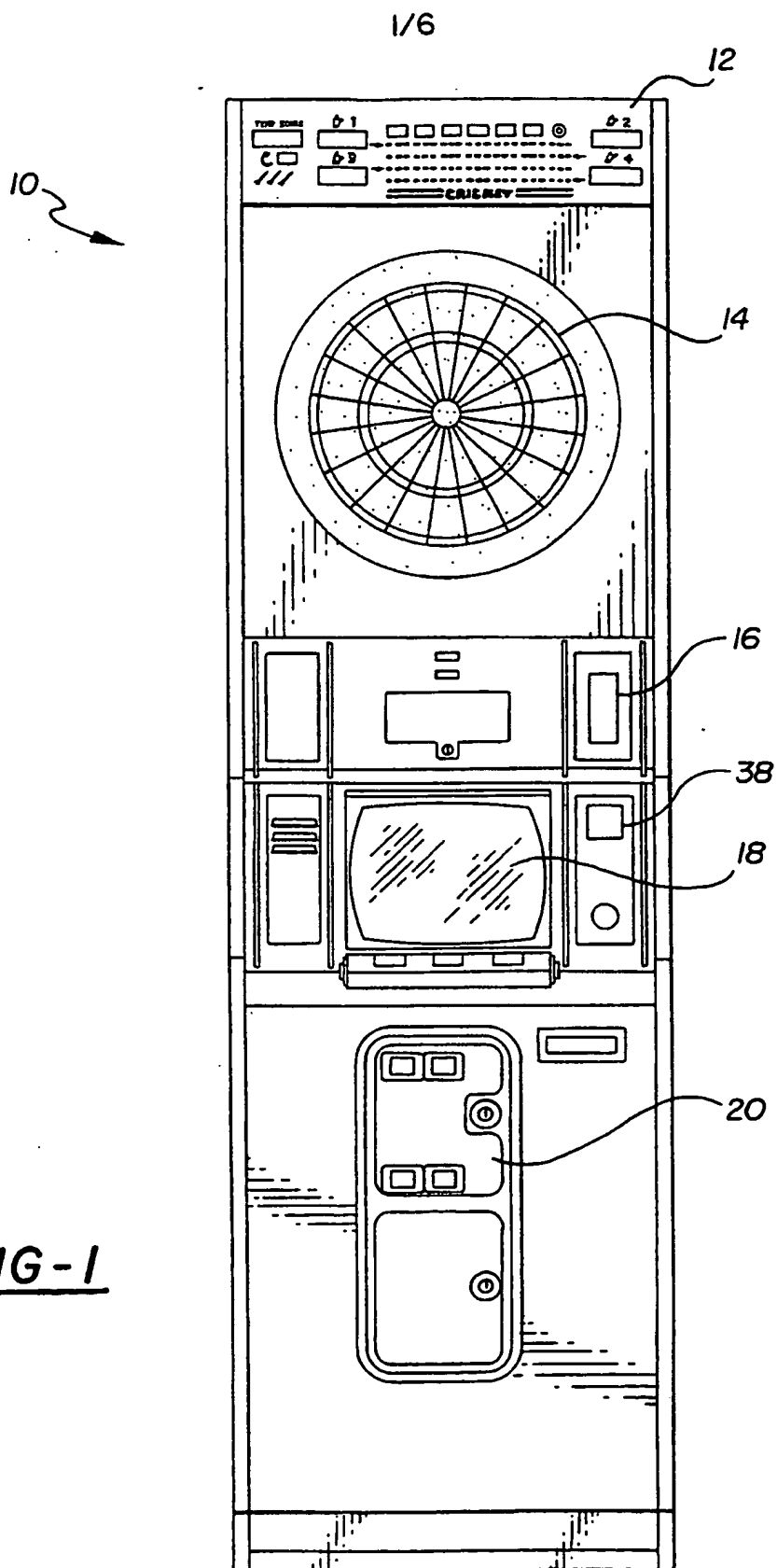
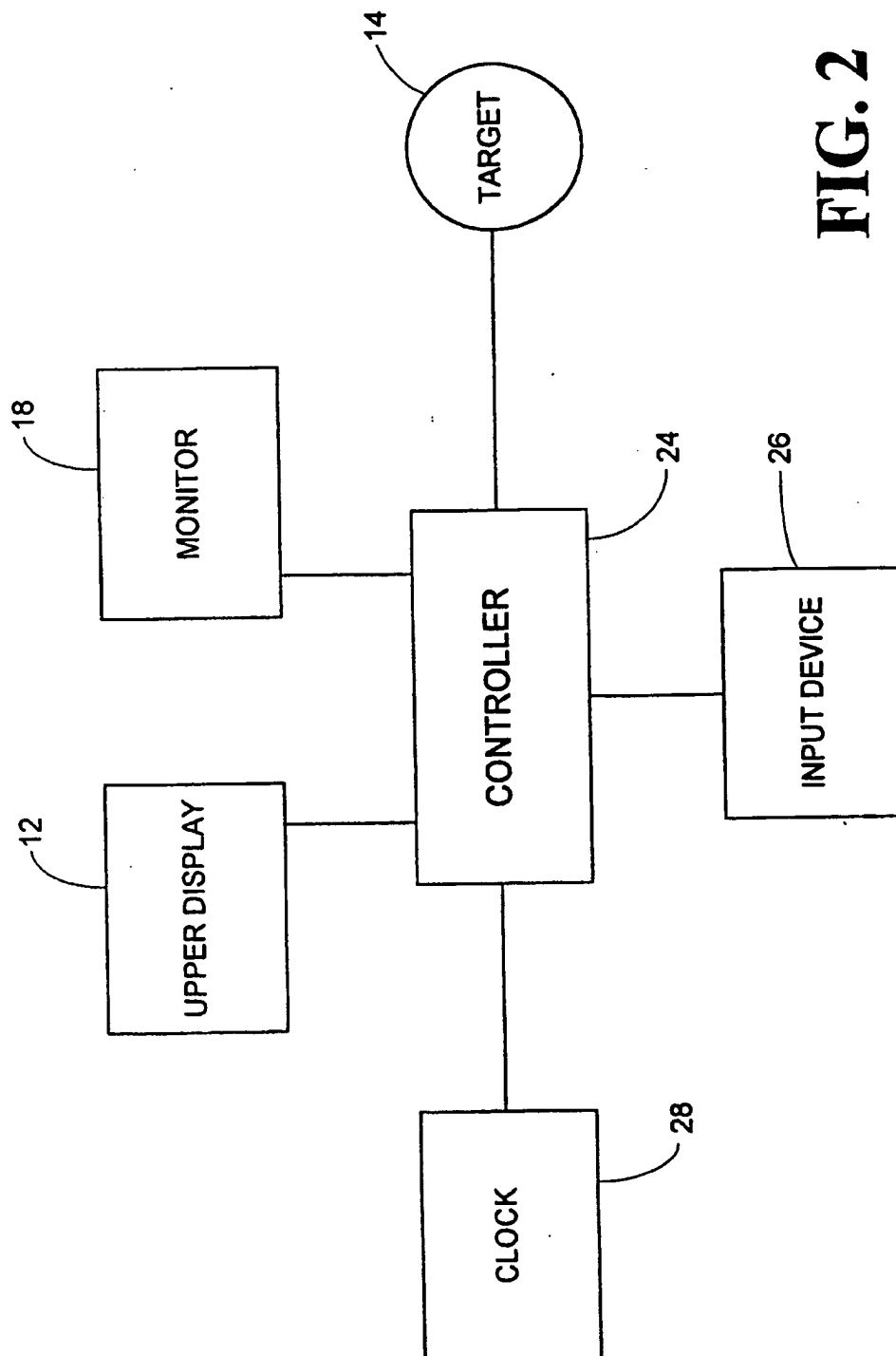


FIG-1

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**FIG. 2**

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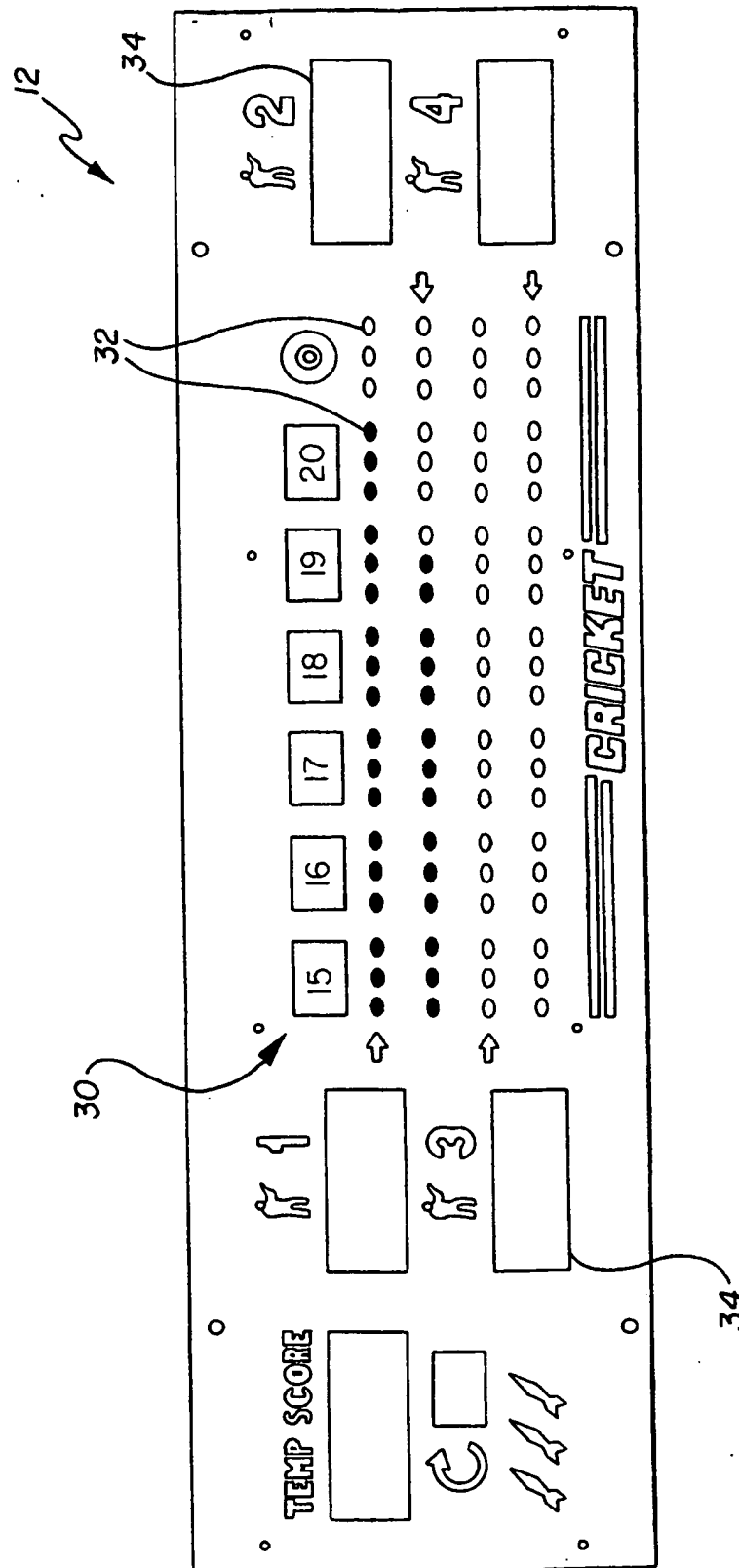
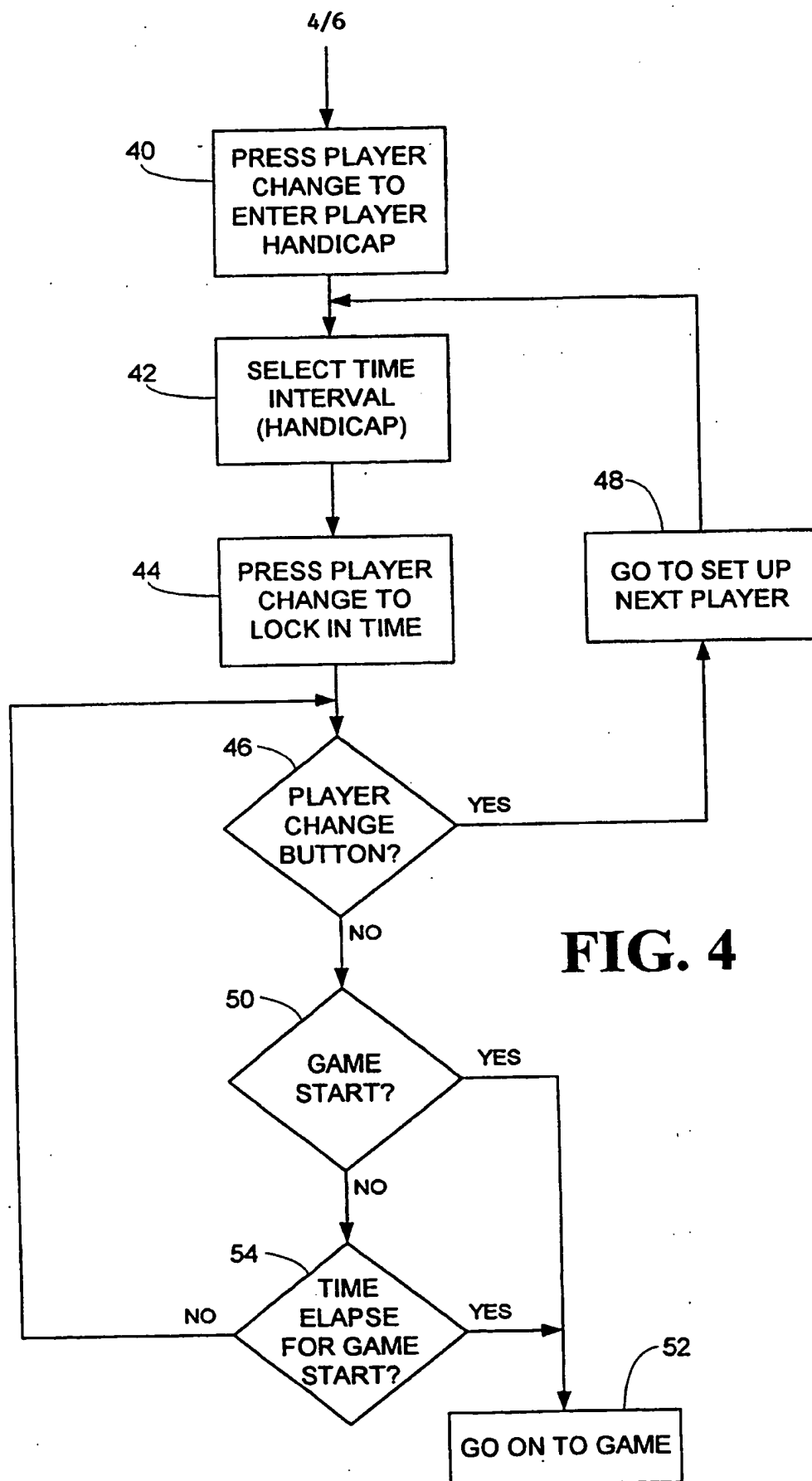
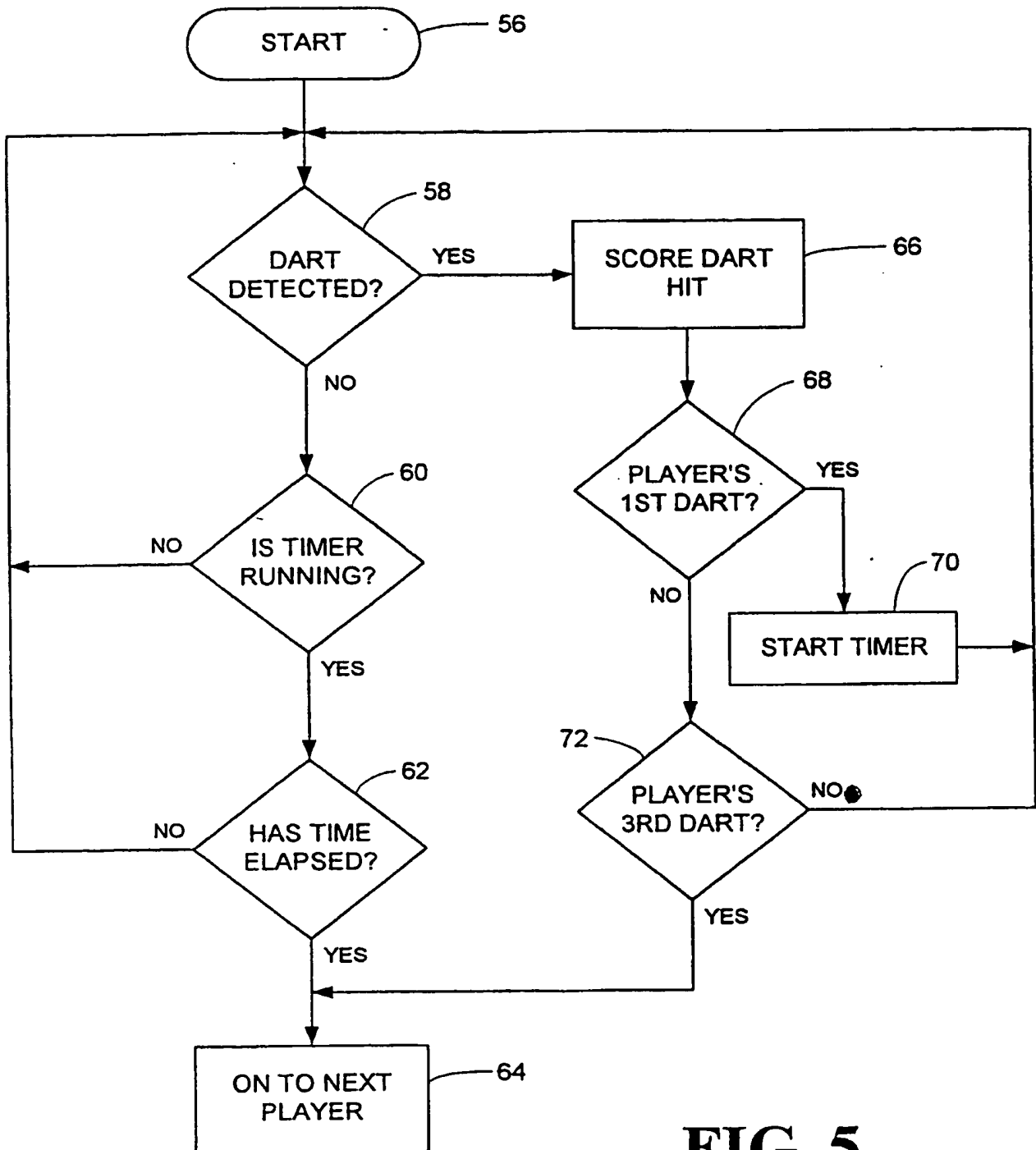


FIG - 3

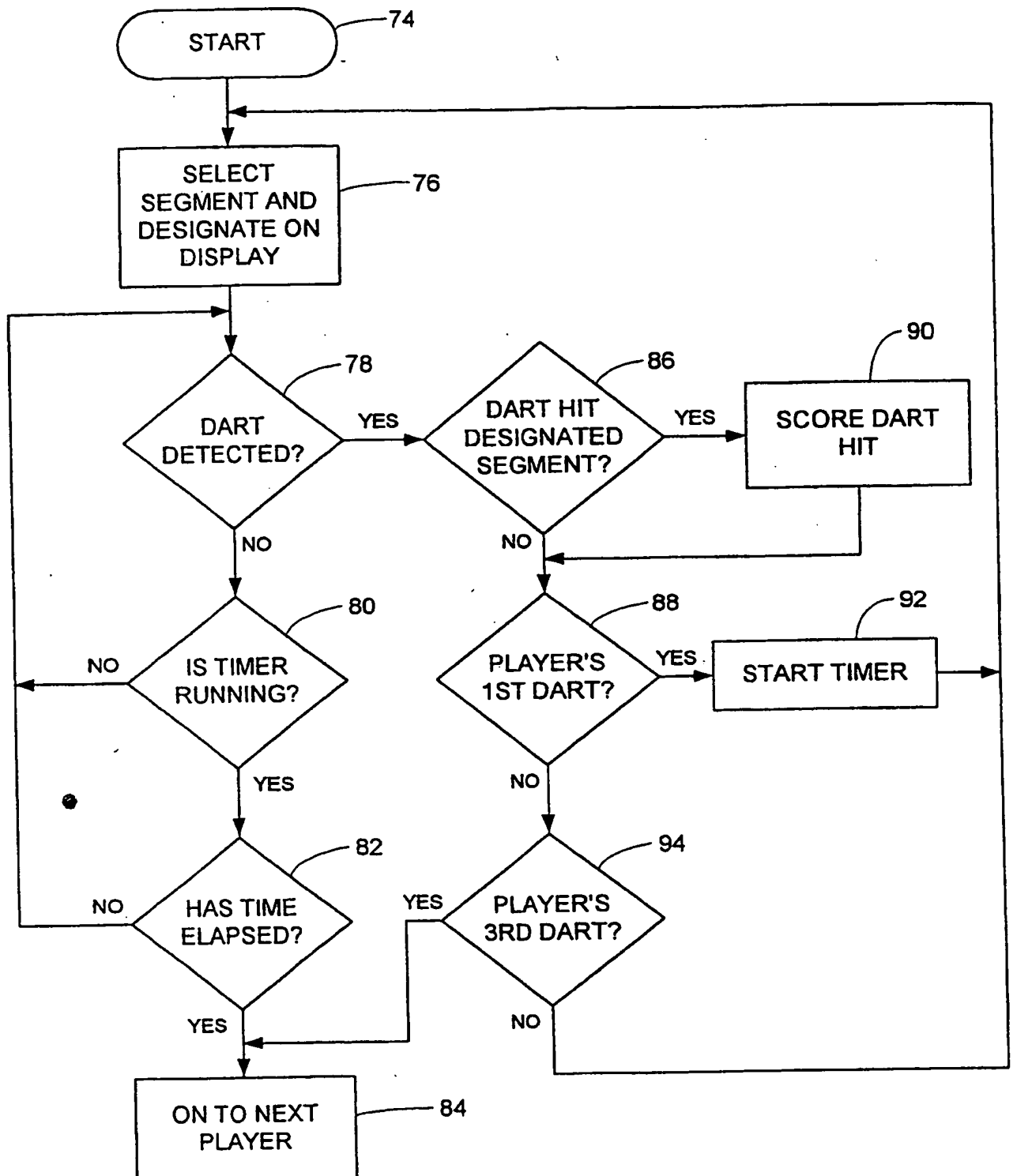
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**FIG. 5**

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**FIG. 6**

## INTERNATIONAL SEARCH REPORT

 International application No.  
 PCT/US97/00693

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F41J 5/04

US CL : 273/371

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 273/371, 373, 374, 376-378

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| Y         | US 4,974,857 A (BEALL et al.) 04 December 1990, whole document.                    | 1-22                  |
| A         | US 4,807,887 (DEVALE et al.) 28 February 1989, whole document.                     | 1-22                  |
| A         | US 4,567,561 A (HONEKMAN et al.) 28 January 1986, whole document.                  | 1-22                  |
| A         | US 4,955,967 A (HOURIET, JR. et al.) 11 September 1990, whole document.            | 1-22                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

\*

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Authorized officer

MICHAEL O'NEILL

Telephone No. (703) 308-2656

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